Application of Nano-Silica and Bentonite to Paper Mill Sludge Dewatering

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ABSTRACT

Nano-silica and bentonite have successfully been used in a papermaking dualretention system to help increase the retention of fines and fillers. Nanomontmorillonite although has not been widely applied like nano-silica or bentonite but it owns a similar property to nano-silica and bentonite: the main composition is silica oxide (SiO2) and aluminum oxide (Al2O3). There are a few studies on their application to sludge dewatering purposes,however. Fly ash also is mainly composed of silica oxide and aluminum oxide and it is known that fly ash could be used as an agent to enhance dewatering efficiency but none of works mentioned dewatering mechanism of dewatering system using fly ash clearly. We enlisted the help of a paper mill in central Taiwan which produces cultural and industrial paper products and which applies sedimentation and a single-stage activated sludge (AC) process to treat its mill effluent.The primary sludge and the wasted activated sludge (bio-sludge) were collected for the experiment. In stage 1, a conventional cationic polymer and a nano-silica (a bentonite) preparation were respectively used as a dewatering agent and co-agent to see whether the dewatering efficiency could be enhanced. Sludge dewatering efficiencies were quantified using the specific resistance to filtration (SRF), capillary suction time (CST) and colloidally dissolved (particles) charge (PCD) methods. A 23 factorial experimental design was used to delineate the effects and interactions of the sequence of polymer addition and the dosage. Analyses of the factorial design on the CST, SRF and PCD tests showed that for the primary sludge all 3 variables under investigation were significant, but none showed interactions with each other; for bio-sludge test results demonstrated stably significant effect of polymer but nano- silica (bentonite) and addition sequence. Besides, tests with bio- sludge also revealed interactions between variables were negligible. We determined that the cationic polymer should be vadded first, followed by the anionic nano-silica (bentonite). The reverse sequence of addition was largely deleterious to the dewatering of the primary sludge. In stage 2,experiments were conducted to compare dewaterability of sludge using single-conditioner system (polymer only) and co-conditioners system (polymer together with nano-silica, bentonite, nano-montmorillonite, fly ash). Based on results from stage 1, we assessed and selected conditions (dosage of conditioners and the sequence of addition) that were able to result in the best dewaterability for each dewatering system and then compare dewaterability of systems at such best conditions. The experimental esults indicated that the co-conditioners system dewatered more effectively than single-conditioner system. Besides, a dewatering mechanism was proposed to illustrate the role of nano-silica, bentonite, nano-montmorillonite and fly ash that helped improve dewaterability of the co-conditioners system.

Keywords : nano-silica, bentonite, nano-montmorillonite, fly ash, primary sludge, biological sludge, capillary suction time (CST), specific resistance to filtration (SRF), PCD.

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